The Application of the FDEM Program Package with Error Estimate to Industrial Problems

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Abstract. The Finite Difference Element Method (FDEM) program package is a robust and efficient black-box solver that solves arbitrary non-linear systems of elliptic and parabolic partial differential equations under arbitrary non-linear boundary conditions on arbitrary domains in 2-D and 3-D. FDEM is an unprecedented generalization of the finite difference method on unstructured finite element meshes. From the difference of formulas of different order we get an easy access to the discretization error. By the knowledge of this error the mesh may be refined locally to reduce the error to a prescribed relative tolerance. The error estimate is a unique property for such a general black-box. In addition, the FDEM program package is efficiently parallelized on distributed memory parallel computers.

In this paper we demonstrate the usefulness of the FDEM program package by its application to several industrial problems. This gives completely new results as up to now people have solved these problems blindly, unaware of the error of their solution.

The first problem is the numerical simulation of a microreactor where we have one chemical component entering through the main channel and one chemical component entering through a side channel so that there is a reaction of the components. We want to examine the flow field and the behaviour of the chemical components.

The second problem is the heat conduction in a high pressure Diesel injection pump. This problem is based on a fluid-structure interaction problem, and we now compute the temperature distribution in the injection pump additionally.

Finally, we simulate the distribution of the temperature in a DC/AC-converter module with six power-MOSFETs heated with uniform power. At the bottom of the module air cooling is applied. In contrast to the first two elliptic problems, this is a 3-D parabolic problem.